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Keywords

bluetooth, wireless, network, infrastructure, computing, multimedia, device, guidebooks, mobile

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A Bluetooth Wireless Network Infrastructure for Multimedia Guidebooks on Mobile Computing Devices

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Abstract

This paper describes the implementation of a Bluetooth Village Guide Book (VGB) scenario for use in the Kelvin Grove Urban Village located in Brisbane, Australia. An Information Point Station Network (IPSN) was developed, along with software for two types of mobile computing devices. The implementation consists of several Information Point Stations (IPSs) placed at locations of significance, with access to information items on a centralized server. Once registered, the user is given the opportunity to experience context-aware information on demand and in various multimedia formats. These information items are selected by the user, either by way of a menu system appearing on their mobile computing device or a more intuitive pointer-tag system. Information items are then 'beamed' via Bluetooth to the user's mobile computing device for the user to view

The implementation was found to be successful and was tested with multiple users accessing information items from a given IPS as well as multiple IPSs attached to the centralized server. Still, there is further work to be done on the VBG software, the user registration system and on creating an embedded solution for the individual Information Point Stations.

1. Introduction

In recent years, the development of sophisticated mobile computing technology has lead to the widespread usage of mobile computing devices (MCD) such as mobile phones and personal digital assistants. This has lead to new ways in which people can access and share information. The sophistication of MCDs has also lead to the development of mobile multimedia services and communication features. Applications such as web browsing and game playing are now common features on mobile phones. The Connected Communities Project associated with the Australian Centre for Interactive Design aims to build an information communications technology infrastructure that allows residents in a community to share general information about their environment using MCDs.

This paper presents an application by the Connected Communities Project to develop a Multimedia Guidebook information system for use in the Kelvin Grove Urban Village [2], located in Brisbane Australia. The Multimedia Guidebook information system allows the user to access specific information related to their immediate surroundings. Multimedia Guidebooks are commonly used in museums and other tourist facilities. The information accessed can be images, audio or text. The guidebook also has authoring features which allows the user to leave text comments related to their location. These comments can be viewed by other users at that location.

The multimedia guidebook system implementation consists of information point stations (IPS) placed at specific locations of interest. A point of interest can be a monument, a building or any article of significance. Each information point station contains media information relevant to its location. The user can use their personal digital assistant (PDA) or mobile phone to access media information stored in an information point station. The transfer of media information between the IPS and the user's MCD is facilitated using the Bluetooth wireless communication protocol.

Bluetooth was selected as the medium of choice due to its prevalence on most modern mobile computing

devices such as Personal Digital Assistants and mobile (cell) phones. This fact, coupled with the nature of Bluetooth communications lacking the requirement for line-of-sight meant users could retrieve location-aware information at the "locality" level. The type of media material transferred includes text, images and audio formats.

Another interactive method of selecting information from the guidebook was also developed. It consists of a pointer and tag system that allows the user to select to view information without using their mobile computing device. The user selects the information to be accessed by aiming a pointer at a tag.

This paper is organized into 6 sections. Section 2 presents a review of related work. Section 3 describes a typical user scenario. Section 4 discusses the implementation of the multimedia guidebook network infrastructure. Future areas of investigation are discussed in section 5 and conclusions are drawn in section 6.

2. Related Work

Multimedia Guidebooks can be found in museums and other tourist attractions. Usually guidebooks support only audio information but there are projects to develop more sophisticated guidebooks. There are two main types of multimedia guidebooks. The first type is involves the information being transferred to the guidebook on request. The second type already has the information stored on the mobile computing device. Examples are the Exploratorium [6] and the Cyberguide guidebooks [3]. These guidebooks have been developed for older PDA platforms. No guidebooks have yet been developed for the latest smart mobile phones. Existing guidebooks tend to use older short-range wireless protocols such infrared communications. This is due to the widespread usage of infrared transceivers on older PDA platforms. Infrared is not as widely integrated into mobile computing devices as Bluetooth [4] has become. Infrared has been surpassed by Bluetooth in many applications because it does not require line of sight, supports ad-hoc networking and has more robust data communications.

The Exploratorium guidebook provides the user with information about exhibits in a museum. The Exploratorium guidebook deploys Radio Frequency ID (RFID) beacons, 802.11b wireless LAN and HP Jornada PDAs. When a user with a PDA comes within range of an exhibit that has a RFID beacon, the beacon's ID is sent to the PDA via infrared. Information about the exhibit is requested by the PDA and the result is returned via the 802.11b LAN. The Cyberguide is a map guide that allows the user to find their location on the map of a venue. It uses specialized infrared tags to determine the user's location and PDAs. The infrared tags are at known locations on the map of the venue. When the user comes with in range of an infrared tag, their location can be displayed on their PDA's map.

Pointers more commonly known as remote controls are used in everyday life to control devices such as television sets. Pointers can be classified in terms on the communication medium used. Most commonly used pointers use infrared. There are projects to develop pointers that use laser light. One such project described in [7] developed a laser pointer linked to a PDA so that it can control devices remotely. One of the reasons for using laser rather then infrared is that it provides the user with a better visual mechanism to point at a device as suggested by [5]. So far pointers have not been used with guidebooks or other similar applications that require the user to select information.

3. User Scenario

The scenario of a Multimedia Guidebook gives the user the opportunity to experience context-aware information on demand in various multimedia formats. Typical interaction between a user's mobile computing device and the Information Point Station Network (IPSN) involves 3 major processes: a registration process; a connection and requesting process; and an online-authoring process.

Before being given access to the IPSN, a user is required to register and download the Village Guide Book (VGB) software onto their mobile computing device (MCD). The user is assigned a unique User Identifier (UID) which is used to authenticate the user when access to the IPSN is attempted. It is envisaged that this registering process could also involve the setting of personal viewing preferences to further adapt the user's experience of the information available from Information Point Stations (IPS).

As the user roams around the Kelvin Grove Urban Village site, he/she may choose to access the IPSN when approaching a point of interest near an IPS, at which point, the user will run the VGB software on their MCD. Once the software has established a connection to the IPS, the user is able to browse a menu of information items related to that point of interest. An example of this menu system is shown in Figure 1a). When the user selects a menu item, the corresponding information is downloaded wirelessly from the IPS and seamlessly executed by the MCD.

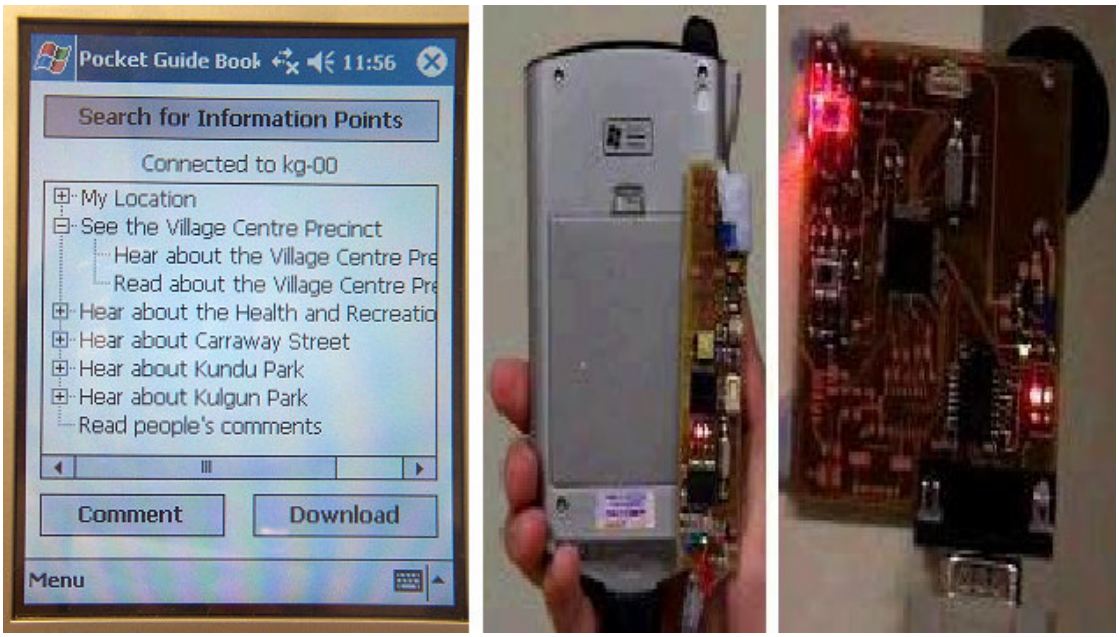

Figure 1. a) Menu Browser on the IPAQ – b) Pointer prototype – c) Tag prototype

Information items can be audio, text or image files. Once the user has finished using the IPS, the VGB software will disconnect from the IPSN.

The other method that a user may employ to access information from the IPSN is by way of a pointer (Figure 1b) and tag (Figure 1c) system also developed for the purposes of this scenario. This pointer-and-tag system allows the user to point to the specific information they require, without the need of connecting to a particular IPS and searching through a menu for the information they require. The pointer is attached to the MCD, and the user intuitively points this to the tag associated with the information they would like to view. The user's experience of an information item once it is downloaded via Bluetooth is the same regardless of how the user selected it.

The final process in the user's interaction with the IPSN, is the process of online-authoring. This is the process whereby a registered user can request and view a piece of information and comment on it for the benefit of the rest of the community for the purpose of establishing a dynamic repository of personal annotations and recommendations. Currently, the VGB software offers the possibility for the user to upload a textual comment for any viewable item. This notion of online authoring could be extended to accept photos or other multimedia information from MCDs.

The goal of offering context-aware information is achieved by ensuring that information retrievable from a given IPS pertains to local sights, important nearby artifacts, or tagged items located physically near the IPS. For example, information regarding 'What's On' at the La Boite Theatre can be accessed at the IPS closest to it. Further goals could also include central user personal preferences to offer both user- and context- aware information.

4. IPSN Infrastructure

The Multimedia Guidebook system implementation consists of information point stations (IPS) placed at specific locations of interest. Each IPS forms part of an Information Point Station Network (IPSN). The IPSN is shown in Figure 2. The IPSN consists of a central server, information point stations, mobile computing devices and pointer-tag system. The server controls the IPSN. It communicates to each information point station (IPS) via Ethernet. Each IPS contains a wireless Bluetooth transceiver and may also connect to tag devices. The Bluetooth transceiver is used to communicate to the mobile computing devices. The mobile computing device can be a PDA or a mobile phone. The MCD is used by the user to select and view information from the IPS. Additionally the user can use the pointer to select information items to view.

Figure 3 shows the different communication channels used. The Bluetooth serial port and Object Exchange File transfer (OBEX-FTP) profiles are to connect the MCD and the IPS. The serial port profile (SPP) is used as a control channel. A specialized

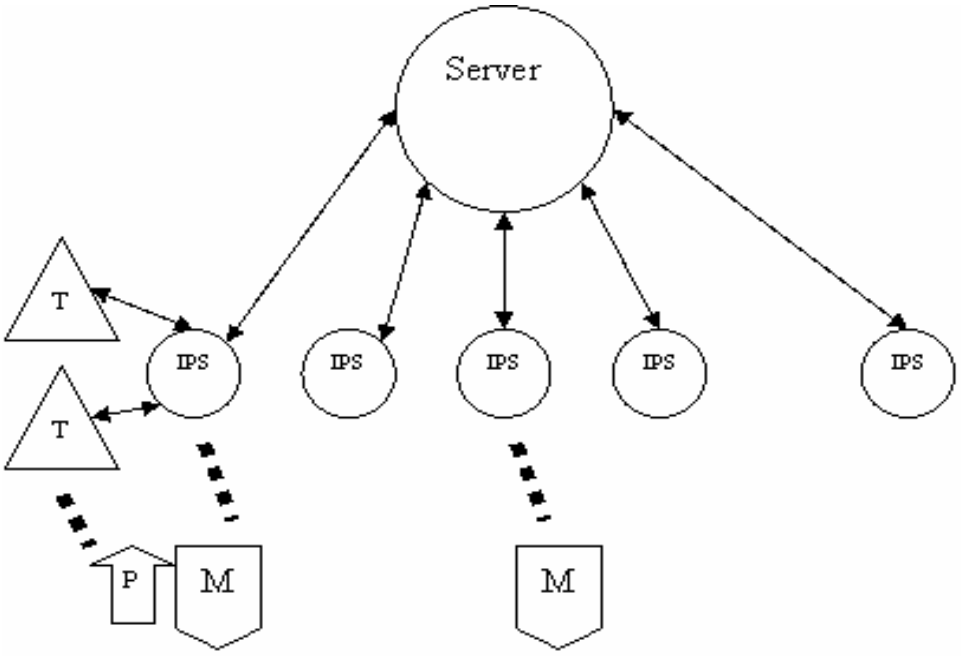

Figure 2. IP Station Network. (M = Mobile Device, P = Pointer, T = Tag, IPS = IP Station)

control protocol was used to request information from the IPS. The OBEX-FTP profile is used to transfer files from the IPS to the MCD. An Ethernet connection is used to connect the IPS to the Server. The tag system is connected via conventional RS232 to the IPS.

4.1. Server and IPS Outline

The function of the server is to monitor each IPS and control its user database. Each user database contains the user Identifiers (UID) and preferences of all registered users. The server is able to update each IPS's user database and can monitor the status of the IPSN. This includes displaying statistics such as the number of active users or the number of requests for a particular item. The server consists of a Linux computer with an Ethernet hub. Communication to each IPS is done using the TCP/IP networking protocol. Programming was performed using C with the open source GCC compiler.

The function of the IPS is to provide a Bluetooth access point to the IPSN. The IPS will authenticate the user and supply the requested information items. Statistics such as the number of active users or the number of requests are recorded and sent to the server. The current implementation of the IPS is a Linux computer with a wireless Bluetooth USB Adapter. Programming was performed using C with the open source GCC compiler. The open source Linux Bluez Bluetooth stack [1] is used to facilitate the Bluetooth connectivity to the mobile computing device. Using the Bluez Bluetooth stack was ideal for this project because it was easily customized to suit the project requirements. The Bluez Bluetooth stack is not officially Bluetooth certified but it has been used and available for at least 4 years, so it is reasonably stable and supports most Bluetooth devices.

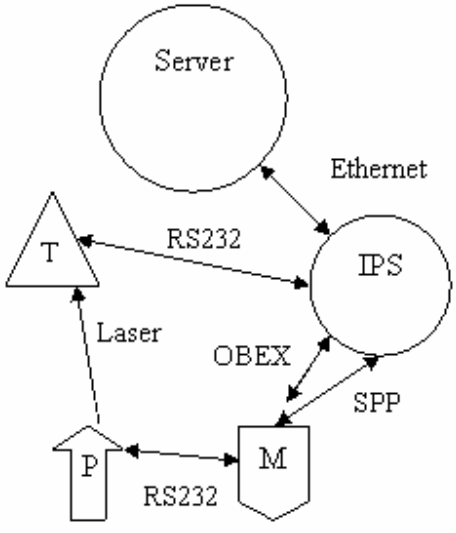

Figure 3. Communication Channels

4.2. Mobile Computing Devices

In the context of a Multimedia Guidebook scenario, the mobile computing device (MCD) functions primarily as an item menu browser and item requester. The MCD software allows the user to browse for information items and initiates the connection to the IPSN. The user's experience of media information such as images, text or audio is achieved by using the corresponding viewers or audio players on the MCD. For example, if an image was to be viewed, it would be opened using the onboard software image viewer. Text information could be viewed either as text files or PDF documents, depending on what was more appropriate for the MCD. All viewers were either integral to the MCD, or freely downloadable.

The MCD software was implemented on a HP IPAQ 5550 PDA running Pocket PC 2003 and a SonyEricsson P910i SmartPhone running Java 2 Microedition (J2ME) [9]. The software on the HP IPAQ was created using the C# language from Microsoft Visual Studio .Net (MVSN) for Pocket PC 2003. The Microsoft Pocket PC 2003 or Windows Mobile 2003 operating systems are commonly used on most PDA devices currently available, making MVSN the obvious development choice for the IPAQ and J2ME is supported to some degree by most SmartPhone devices.

One of the reasons for developing the software on two types of devices was to explore and compare the various hardware/software features and development capabilities of each MCD. It was found that software development kits (SDK) for MCDs in general are limited in directly accessing external IO features such as Bluetooth profiles or serial ports. Additionally, different mobile phones implement and support a varying number of Java Specification Requests (JSRs).

The SDKs used were those that were readily or freely available such as MVSN and J2ME. There are commercially available SDKs for different mobile computing devices that provide much greater access to the MCD's features than those used, however they are more mobile phone-specific. Table 1 shows some of the main programmable features of both MVSN and J2ME.

The IPAQ software was also integrated with the pointer-tag system. This was done by connecting the pointer to the MCD using an available RS232 serial port in order to set the UID used by the pointer to request a particular tagged item.

4.3. Pointer-Tag System

The pointer was implemented as an embedded solution using a microcontroller and a custom laser transmitter. The pointer was designed to a have a low physical profile in order to make it less obtrusive to the user. The tag was also implemented in a similar manner to the pointer except that it employed a laser detector to determine when the user had selected the tag. The pointer transmits the user's Identifier (UID) to the tag. Once the UID has been received, the tag transmits a request for information instruction using a specialized control protocol, to the IPS via RS232.

5. Future Work

Although functional prototypes were created of all components of the IPSN system, some areas were highlighted for further work. Registration (both on-line and on-location) needs to be implemented, taking note of security and privacy issues. This is particularly important when considering community feedback in the form of comments. Further capabilities for public commenting, like adding photos and other multimedia as comments, are yet to be implemented.

Other areas where further work can be concentrated are with the user preferences and thus user-aware information. Also, other wireless protocols could also be considered, such as GPRS, for the transfer of files. For the hardware, the information point stations (IPS) are yet to be converted to an embedded processor platform solution that runs the uClinux operating system. An embedded IPS platform could be housed in

Table 1. Mobile Computing Device Programmability Feature Comparison

Features	H5550 IPAQ (MVSN)	SonyEricsson P910i (J2ME)
File Access	Supported	Not supported
Bluetooth Connectivity	Supported through the use of third party libraries	Supported by JSR 82 [8]
Bluetooth File Transfer	Supported through the use of third party libraries	Not supported by this implementation of JSR 82 [8]
Text, Image and Audio Display	Supported	Supported
Other Features	RS232 Serial Port, Wifi support	SMS support, Symbian programming support

a special casing that makes it less susceptible to environmental conditions such as temperature.

6. Conclusion

A Multimedia Guidebook information system was created to allow users to access specific information related to their immediate surroundings using their mobile computing devices. The guidebook was designed to provide information about the Kelvin Grove Urban Village in Brisbane Australia. This village guidebook (VGB) allowed the user to view images, listen to audio and read textual information at a specific location. The VGB also allowed the user comment on a specific piece of information. Commentary could be viewed by other users that are in specific location. Another interactive method of selecting information from the guidebook was developed. It consists of a pointer-tag system that allows the user to select to view information aiming a pointer at a tag. The requested information is then viewed on their mobile computing device.

The infrastructure created consisted of information point stations (IPS) placed at locations of significance. A network of IPS units was created. Each IPS communicated to the user's mobile computing device using Bluetooth communications. The types of mobile computing devices that could be used are PDA and mobile phone platforms. It was also found that the programming capabilities of mobile computing devices are limited in terms of input/output access application programming interfaces. This is usually due to the limitations of the available software development kits. The future work of this project includes developing user registration, creating embedded information point platform and improving the VGB software.

7. Acknowledgements

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8. References

[1] "Bluetooth Z - Official Linux Bluetooth Protocol Stack", *http://www.bluez.org*

[2] "Kelvin Grove Urban Village", *http://www.kgurbanvillage.com.au/*

[3] G. D. Abowd, C. G. Atkeson, et al., "Cyberguide: a mobile context-aware tour guide," *Wirel. Netw.*, vol. 3, pp. 421-433, 1997.

[4] Bluetooth SIG, "Bluetooth Specification Documents", *https://www.bluetooth.org/spec*

[5] D. Cavens, F. Vogt, S. Fels, and M. Meitner, "Interacting with the big screen: pointers to ponder," in *CHI '02 extended abstracts on Human factors in computing systems*. Minneapolis, Minnesota, USA: ACM Press, 2002, pp. 678-679.

[6] S. Hsi, "The Electronic Guidebook: A study of user experiences using mobile web content in a museum setting", *IEEE International Workshop on Wireless and Mobile Technologies in Education*, 2002.

[7] M. Ringwald, "Spontaneous Interaction with Everyday Devices Using a PDA", *Workshop on Supporting Spontaneous Interaction in Ubiquitous Computing Settings at Ubicomp 2002*, Gothenburg, , Sweden, 2002.

[8] Sony Ericsson, "Developers Guidelines: Java J2ME for P900 and P910 series mobile phones", *http://developer.sonyericsson.com/site/global/docstools/java/p_java.jsp*

[9] Sun MicroSystems, "Java 2 Platform, Micro Edition", *http://java.sun.com/j2me/*